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COGNITIVE STRATEGIC GROUPS AND LONG-RUN EFFICIENCY EVALUATION: THE CASE OF SPANISH SAVINGS BANKS*

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Abstract

In the framework of Cognitive Approach, this paper proposes a new method to identify strategic groups (*SG*) using Data Envelopment Analysis (*DEA*) methods. Two assumptions are maintained in the *SG* literature: first, firms grouped together value inputs and outputs similarly, and, second, some degree of stability in those valuations should be identified. Virtual weights obtained from *DEA* are extremely useful in the valuation of the strategic variables, but a problem emerges when longitudinal analysis is performed. This problem is addressed by defining a long run *DEA* evaluation. *SGs* are determined by means of Cluster Analysis, using virtual outputs and virtual inputs as variables and Spanish savings banks as observations. The traditional method of determining *SGs* by clustering on the original variables is also applied and the results are compared. It is shown that the long run *DEA* weights approach has advantages over the traditional methodology.

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INTRODUCTION

One crucial question in the field of strategy is why firms in the same industry perform differently. Strategic Group (hereafter *SG*) literature proposes an answer to this question: the differences in the collective behavior of the *SGs* lead to durable differences in profitability. The problem is that, for empirical and theoretical reasons, research on *SGs* has been somewhat unsatisfactory. From the empirical point of view, no conclusive evidence has been found for the hypothesized group-performance linkage (McGee and Thomas, 1986; Thomas and Venkatraman, 1988; Barney and Hoskisson, 1990), and most part of the research has been limited to the static (specific to a given time-period) identification of *SGs*. As Cool and Schendel (1987) pointed out, this static viewpoint implies that the observed *SGs* and the differences in their profitability are invariant. As this assumption is problematic, it is imperative for a longitudinal expansion of the analysis because, as Hatten and Hatten (1987) pointed out, unless some degree of stability would be identified, the very concept of an *SG* had little value.

On the theoretical side, some authors (e.g. Cool and Schendel, 1987) state the limited progress achieved in the acceptance of the concept of *SG* based on industrial organization theory. This has led to new theoretical approaches, namely the cognitive perspective (Fombrun and Zajac, 1987; Osborne et al., 2001; Peng et al., 2004; Porac et al., 1995; Reger and Huff, 1993) or the resource determinants of performance differences (Dierickx and Cool, 1989; Mehra, 1996). In particular, cognitive approach theorists suggest that managers have cognitive or perceptual maps of intra-industry structure (Bogner and Thomas, 1993) establishing different *SGs* from those obtained under the industrial organization approach (Reger and Huff, 1993). Differences and similarities between both approaches have been included in the integrative model developed by Bogner and Thomas (1993), who concluded that competition and performance are influenced more directly by cognitive perceptions of

SGs than by industrial organization groupings. Although limited empirical evidence have been found, it proves that strategic groups formed according to manager's perceptions predicts better the performance differences across firms in a particular industry (Reger and Huff, 1993).

The cognitive approach implies difficulties for researchers due to the fact that mental patterns of managers are rarely visible for external observers. Therefore, researchers have tried to use simple approximations to cognitive models. For instance, Peng et al. (2004) have demonstrated that the ownership is a powerful criterion to predict the existence of *SGs*. Although remaining relatively unexplored, another criterion for identifying cognitive groups may be the production function approach (Athanassopoulos, 2003; Day et al., 1995, and Prior and Surroca, 2006). Day et al. (1995) pointed out that, when designing strategies, managers cognize a causal model relating operational decisions with the attainment of an objective function that, in general, includes multiple goals. This causality, in the very definition of strategy, justifies the need to identify the characteristics of the production function that maps resources to the attainment of the strategic goals.

In this paper, we focus on the production function and, more specifically, on the relative importance managers place on specific key decision variables – the marginal inputs and marginal outputs rates. These variables represent the rate of contribution of each key decision variable to the general corporate strategy (Thanassoulis, 1996). Therefore, our proposal consists of grouping together firms according to the similarities their managers' place over key decision variables. Concerning *SGs* literature using the production function approach, Prior and Surroca (2006) have defined cross-sectional Data Envelopment Analysis (hereafter *DEA*) models to determine marginal inputs and outputs rates, but it remains to be defined the longitudinal extension of the analysis in order to fulfil a dynamic analysis on the *SGs*. In order to do this, an idiosyncratic *DEA* problem must first be addressed: the lack of time-consistency of the information obtained from the contemporaneous production functions. We apply our proposal to the Spanish savings bank industry over the period 1998-02, and, once *SGs* have been determined, we assess the impact of *SG* membership on firm performance. A comparison between our *SG* configuration vis-à-vis that derived from standard clustering firms on the basis of similarities in key decision variables is also performed, and the results of this analysis show the advantages of using our cognitive approach.

Three main contributions can be distinguished from our work. First, we propose a simple criterion for identifying cognitive groups based on the concept of production frontier. Specifically, the information provided by production frontier helps us to approximate managers' mental models. Secondly, we provide evidence in favor of the cognitive approach. Finally, from a methodological point of view, this article presents and discusses the advantages of the definition of a *DEA* model focused on the long-run evaluation.

The remainder of this article is structured as follows. First, we establish the connection between cognitive *SGs* and *DEA*. Building on this connection, in the methodological section we extend *DEA* frontier model to define a new long-run *DEA* evaluation that offers a stable common set of virtual weights for each unit, which is the basis for identifying *SGs*. Next, we describe the sample, the strategic variables and the stages we follow to finally determine the *SGs* in the Spanish savings bank industry. The article concludes discussing the findings and presenting the significance of the study.

LINKING COGNITIVE GROUPS AND DEA-PRODUCTION FRONTIERS

In industries populated by so many competitors, the individual consideration of each one is impossible and managers tend to summarize competitors' strategies (Porac et al., 1995). In such cases, decision-makers tend to simplify the original information into abstract categories and, subsequently, to elaborate new information sets aimed to condense the existent knowledge (Reger and Huff, 1993). Thus, a complex cognitive analytical context is translated into a tractable cognitive problem. Cognitive simplification and elaboration leads managers to develop categories to which they assign firms: if managers of different firms share a common cognitive structure they consider each other as rival, and a group identity emerges (Peteraf and Shanley, 1997). Therefore, according to the cognitive approach, a strategic group is considered to be a set of firms whose decision-makers hold shared mental models of strategy within their industry (Reger and Huff, 1993).

With respect to collective behavior, a distinctive feature of cognitive groups is that managers perceive competing firms to be similar on a basis of important strategic dimensions (Porac et al., 1995; Reger and Huff, 1993). Rather than searching for a universal and exhaustive taxonomy of firms, managers isolate only those strategic dimensions that are viewed as critical (Porac et al., 1995). From this perspective, firms' activities are conceived as a limited number of central dimensions – the competitive priorities – that are particularly informative and predictable of overall organizational activities.

In a complex context, managers observe *SGs* by means of the specific type of relationships among the competitive priorities and with the other strategic dimensions (Porac and Thomas, 1990). The relationships observed can be classified in two broad classifications: complementary and mutually exclusive relationships. Complementarities appear when corporate priorities are positively correlated with other, less important, corporate dimensions. Consequently, an external observer can perform a diagnostic of the organizational activities by summarizing the position of the organization in these central attributes (Porac et al., 1995). Further, mutually exclusive defines the internal relationship among competitive priorities. Due to the scarcity of resources, managers make choices regarding which priorities should be outweighed. So, based on their relative importance, firms are compelled to make trade-offs between a number of priorities. Importantly, these trade-offs are explained by the characteristics of the technology employed by the firm (Schroeder et al., 1995).

Competitive priorities can be summarized with the use of production functions. The existence of strategies imply that managers choose some conversion mechanism relating the inputs – resources committed – to outputs – dimensions of the scope of strategy (Day et al., 1995). In such a conversion mechanism or production function, the marginal relations – the slope of that function – reveal the relative importance of each strategic dimension and the trade-offs between two strategic dimensions (Prior and Surroca, 2006). Therefore, a strategic group distinguishes a set of firms with similarities in the marginal contribution of their strategic decision variables to the overall corporate strategy.

From the preceding discussion, the following points stand out: a) managers' mental models are simplifications of a complex reality; b) competitive priorities are at the center of the mental models; c) these central dimensions are viewed as critical for firm success; d) the identification of *SGs* are based on these competitive priorities and, finally, e) firms in the same *SG* choose to compete on the basis of similar competitive priorities. Given such a conception of *SG*s, in the next section we explain how to use *DEA* models in order to identify competitive priorities.

USING DEA TO ASSIGN WEIGHTS TO EACH STABLE STRATEGIC GROUP

As mentioned earlier, we use *DEA* methods to determine the efficiency in the implementation of the strategy and to assess the relative importance managers place on the key decision variables. This section illustrates graphically the marginal variables and efficiency values yielded by the *DEA* methods (technical details of these methods can be found in Appendix 1).

A *DEA* model does not try to estimate the exact form of the production function, but it uses the existing observations (Decision Making Units, henceforth *DMUs*) to elaborate a non-parametric empirical frontier that envelopes all observations. Applying *DEA*, we obtain an efficiency value for each *DMU* which measures the distance separating a specific *DMU* from the frontier. The *DMUs* that define the frontier are Pareto-efficient and the rest are projected towards the frontier.

No specific transformation function relating inputs and outputs is imposed; neither does it require knowing the weights associated with the above-mentioned variables. Precisely, and by means of a dual transformation of the mathematical programs, it becomes possible to assign a flexible set of weights to each input and output. These weights indicate the marginal contribution of each input/output to efficiency value yielded by the *DEA*. Also, as weights are dependent on the units of measurement, normalized or virtual weights can be used to assess such a contribution in a dimensionless way. Then, from a strategy viewpoint, the size of the virtual weights identify managers' preference among dimensions in corporate strategy.

According to Tulkens's (1986) taxonomy, the standard *DEA* models follow what is so-called a *contemporaneous evaluation,* as illustrated by means of Panel *A* in Figure 1. The most important feature of this evaluation is the absolute independence of the technology between time periods *t* and *t+1*. So, it is possible to evaluate the transformation process of inputs into outputs each period, with no need to assume any technological relationship between two adjacent time periods.

INSERT FIGURE 1 ABOUT HERE

When time periods are connected, the result is what Tulkens (1986) defines as *intertemporal evaluation* (represented in Panel *B* of Figure 1). An intertemporal evaluation assumes a unique reference technology, used to evaluate each *DMU* in every time period (represented by dotted lines in Figure 2) obtaining as many efficiency coefficients as the time periods considered for each *DMU*, but with no temporal connection among them.

Although interested in the intertemporal evaluation, we are looking for stable efficiency figures, representative of the complete time period under analysis. This is possible in maintaining the intertemporal reference technology, but evaluating the aggregate level of the resources and scope variables (what is represented by the bold arrows in panel 2 of Figure 1 and the program *[3]* in Appendix 1). In doing this, we obtain a long run stable efficiency coefficient, representative of the transformation process corresponding to the complete time-period.

We now present a simple example. Figure 2 depicts the contemporaneous frontiers corresponding to time periods *t* (Panel *A*) and *t+1* (Panel *B*), assuming a transformation process with two dimensions of scope (y_1 and y_2) and one resource committed (*x*). As can be seen, some *DMUs* maintain a stable position in the two time periods (units *B*, *C* and *D*) but other units (*A* and *E*) move their respective strategic variables. This implies that the contemporaneous frontiers have different shapes. From the contemporaneous perspective, nothing can be done to connect them. In time period *t*, units *A*, *B*, *C* and *D* are efficient while unit *E* is inefficient. Moreover, the slope of the frontier at the point where each *DMU* is projected represents the rate between output weights – the marginal rate of transformation. In Panel *B* we see the same efficient units, noting the movement in the strategic variables for *A* and *E*.

According to the proposal by Tulkens (1986), Figure 3 presents the intertemporal analysis – see also program *[2]* in Appendix 1. Observe that, although moving its strategic mix between *t* and $t+1$, unit *A* continues appearing efficient in both time periods, but the weights attached to this unit differ substantially across those time periods; $-\left(u_2^t / u_1^t\right)$, in *t*, and $-\left(u_2^{t+1} / u_1^{t+1}\right)$, in $t+1$.

INSERT FIGURE 3 ABOUT HERE

Our proposal is to sort out the temporal inconsistency of the weights consists in considering the aggregation of the subsequent contemporaneous production possibilities set – see program *[3]* in Appendix 1. The implicit assumptions of this proposal are i) the aggregate production possibilities set fulfil convexity and monotonicity (Varian, 1992 and Banker and Thrall, 1992), ii) the aggregate production set satisfies the free input and output disposability condition, and iii) the technological prevalence of constant returns to scale – the only economic assumption reasonable in the long run (Varian, 1992).

Figure 4 illustrates our proposal. When we aggregate variables corresponding to *t* and $t+1$, units *B*, *C* and *D* continue appearing as efficient. Contrarily, this aggregation drives *DMU A* to be considered inefficient. This means, that our proposal of stable long-run evaluation is more demanding than the intertemporal frontier because it requires the joint accomplishment of two properties: 1) to be efficient on a long-run basis (as with units *A*, *B*, *C* and *D*), and 2) to be consistent with the importance given to the variables used (which only units *B*, *C* and *D* accomplish).

INSERT FIGURE 4 ABOUT HERE

The proposal described is a new contribution to the panel data efficiency evaluation literature because, being well-grounded in the microeconomic concept of aggregate production possibilities set, it assigns a single efficiency coefficient and a temporal consistent set of weights to each firm.

DESCRIPTION OF THE SPANISH SAVINGS BANK STRATEGIC DATA

The information used in this study has been taken from the publication "Anuario Estadístico de las Cajas de Ahorros Confederadas" (Statistical Yearbook of the Confederated

Savings Banks) published by “Confederación Española de Cajas de Ahorros” (Spanish Confederation of Savings Banks). Due to the characteristics of the available information, our application is restricted to the time-period from 1998 to 2002. After deleting the savings banks with missing data, those involved in mergers and the extreme observations, our complete panel data included 42 firms.

In the empirical application, we follow the taxonomy proposed by Hofer and Schendel (1978) and later applied by Cool and Schendel (1987) and Mehra (1996). This approach focuses on firms’ strategies by examining their scope and resource deployments. Following this proposal, we take variables generally used in previous studies devoted to the identification of *SGs* in the banking industry (see, for instance, Mehra, 1996, in the *US* banking sector, Canals, 1993, in the Spanish banking industry, and Gual and Vives, 1992, in the Spanish savings bank sector). So, the multi-product nature of a banking firm is measured in three global aspects: 1) product scope, 2) geographical reach and 3) customer proximity. The *Product scope* dimension is captured by six variables: commercial loans (*S1*), portfolio of securities (*S2*), treasury (*S3*), service commissions (*S4*), savings and deposit accounts (*S5*), and interbanking position (*S6*). The *commercial loans* measure is the ratio of commercial loans to financial investments, and it captures the bank’s specialization in domestic economies and small and medium firms. We measure the firm’s orientation towards active investments in stock market by the ratio of *portfolio of securities* to financial investments. The *treasury* variable is the ratio of liquid assets to financial investments, and it is indicative of the conservatism attitude of the bank. The *service commissions* measure is the ratio of commissions due to financial services to products of financial activity. This measure captures a firm’s diversification away from the traditional banking products (loans and savings) towards new services and financial intermediation. The *savings and deposit accounts* variable is the savings and deposit accounts of the private sector divided by the total liabilities; thus, a small value for this ratio indicates a traditional and conservative banking business, based on the traditional accumulation of family savings. Finally, the *interbanking position* is the ratio of net position in financial markets to total liabilities, which is designed to capture the novel and aggressive way of capturing funds by means of the interbank market.

We defined *Geographical reach* using a Herfindahl-Hirschman index. This index is obtained by squaring the ratio of the number of branches of each bank in every Spanish province to the total number of bank branches, and then summing those squares. Formally, the index is defined as:

$$H = \sum_{j=1}^{32} \left(N_{ij} / N_i \right)^2 ; 0 \leq H \leq 1$$

where N_{ij} is the number of branches of the savings bank evaluated in province *j* and N_i is the total number of branches of the bank. Then, we use the following measure of geographical reach in the *DEA* evaluation:

$$S7 : 1 - H = 1 - \sum_{j=1}^{32} \left(N_{ij} / N_i \right)^2$$

The *Proximity to customers* variable is measured by the Herfindahl-Hirschman index corresponding to the market quota of each firm *i* within each province $j \left(j = 1,...,32 \right)$. More specifically, the variable is defined as:

$$S8: \sum_{j=1}^{32} \left(N_{ij} / N_j \right)^2$$

where N_{ij} is the number of branches in province *j* for the *DMU* under evaluation and N_j is the total number of branches in each province.

To determine the characteristics of the inputs, we define three variables measuring a firm’s resource commitments: *physical capital (R1)*, *human capital (R3)* and *credit quality (R3)*. *Physical capital* is measured by the ratio of the depreciation and amortization expenses to operating income; the *human capital* measure is personnel expenses divided by operating income; and the *credit quality* is the ratio of loan loss provisions and write-offs to operating income.

ANALYSIS

To identify *SGs,* we follow a six-step procedure, which is an adaptation of the Fiegenbaum and Thomas's (1990, 1993) proposal to the features of efficiency evaluation. The first step is to identify the contemporaneous importance of each strategic dimension. This is executed by identifying the virtual weights of inputs and outputs of each firm applying program *[2]*.

To see to what extent the assumption of the existence of strategic groups over the time period analyzed can be accepted, in the second step we follow Cool and Schendel (1987) and Fiegenbaum and Thomas (1990, 1993) to test the hypothesis of the existence of stable strategic time periods (*SSTPs*). To identify the time periods, we analyze changes in the means and variance-covariance matrices of the virtual weights, using four methods: a) applying Bartlett's test for the equality of the covariance matrices; and b) testing the equivalence of the means using three methods, viz. Wilks' lambda, Hotelling-Lawley's trace, and Pillai's trace. [1] Once the *SSTPs* hypothesis is accepted, the analysis of similar strategic groups becomes meaningful (Fiegenbaum and Thomas, 1990, 1993).

In the third step, following Elyasiani and Mehdian (1992) we test for the homogeneity of the technology over the years included in each *SSTP*. For two contemporaneous frontiers, to be identical, the probability distribution functions of efficiency values in t and in $t+1$ should coincide. Then, if the null hypothesis cannot be rejected, efficiency values and virtual weights of the years t and $t+1$ can be measured relative to a pooled frontier.

In the fourth step, for each *SSTPs* identified in step 2, an intertemporal efficiency evaluation is performed and the stable long-run virtual weights are obtained.

In the fifth step, Cluster Analysis of the stable long-run virtual weights is performed. To overcome the distortions highlighted by Ketchen and Shook (1996), we use a two-stage process. In the first stage, a Ward hierarchical algorithm is used to define the number of clusters. For a correct identification of the number of clusters, the procedure proposed by Fiegenbaum and Thomas (1993, p. 83) is employed. In the second stage, each firm is assigned to a group using the *K-means* iterative partitioning algorithm. To examine whether differences in the selected dimensions exist among *SGs*, a *MANOVA* is carried out. Differences among groups for each variable are verified using *ANOVA* and Kruskal-Wallis test. Additionally, we use Discriminant Analysis to verify the level of separation across *SGs* and the robustness of the segmentation.

In the sixth step, we verify the superiority of our proposal for determining *SGs* when explaining the variability of profits. Following Mehra (1996,) we conduct a univariate *ANOVA* test to examine the association between *SG* membership and various performance indicators.

After this, we replicate the process of identifying *SGs* (specifically, steps two, five and six) using the original variables. Doing this we verify to what extent our proposal offers better results than the standard application of Cluster Analysis with the original variables.

FINDINGS

The Identification of Stable Strategic Time Periods

In order to identify the so-called stable strategic time periods *(SSTPs)*, the methodology described is applied to both the contemporaneous virtual weights and to the original strategic variables. The results are shown in Table I. The results indicate that, when considering virtual weights, no significant changes, either in the vector of means or in the variance-covariance matrix, occur throughout the years. So, between 1998 and 2002, the savings bank sector maintained stability in the managers' perceptions of which strategic dimensions are more relevant.

INSERT TABLE I ABOUT HERE

When we consider the original strategic dimensions (say, variables instead of their normalized weights), we observe changes in the mean vectors and variance-covariance matrix results of *SSTP* analysis. The changes in the vector of means are significant for every year. On the other hand, comparisons of the covariance matrices between each pair of years show no change. According to Fiegenbaum and Thomas (1990, p. 204), for the accurate determination of *SSTPs* in such situations, the results from the two methods must be examined. Based upon the intersection of the two criteria, it can be inferred that five *SSTPs* are observed during the 1998-02 time period. However, for purposes of comparison, whenever we refer to *SSTPs* identification based on the original strategic variables, we will consider both the *5-SSTPs* and the *1-SSTP* specifications.

Once the *SSTP*-virtual weights are established, the homogeneity of technologies during the 1998-02 time period is tested. Table II shows the results of the test and supports the null hypothesis that the mean (*ANOVA*), the distribution functions (Kruskal-Wallis) and the median (Wilcoxon) of the efficiency coefficient between each pair of years are statistically insignificant. Therefore, we can assume the use of the same technology for each year. Two important implications follow. Firstly, the differences in the efficiency coefficient as well as in the virtual weights are not attributed to production frontier differences. Secondly, the profitability and efficiency differentials amongst firms come from areas other than the process of transforming inputs into outputs: the preferences of managers (Elyasiani and Mehdian, 1992).

INSERT TABLE II ABOUT HERE

Strategic Groups in the Spanish Banking Industry

Once the *SSTPs* and technological homogeneity are established, Cluster Analysis is performed. Results for the inter-temporal virtual weights stratification are shown in Table III. The detailed composition of *SGs* –both when clustering virtual weights and original strategic variables– is tabulated in Appendix 2.[2]

INSERT TABLE III ABOUT HERE

The inspection of the centroids of each *SG* reveals that *SG1* shows a preference for *S2*, the portfolio of securities, and *S3*, treasury. This implies that the savings banks in *SG1* play an important role as bankers to small and medium size businesses. It is worth noting that credit activity, *S1*, is regarded with little importance in the strategy of the firms belonging to this group. *SG1* is also characterized by a focus on attracting funds by means of aggressive formulas, such as inter-banking funds, *S6*. Savings banks in this group give weight to participating in a greater number of geographical markets, *S7*, despite the reduced value of the market quota in each market, *S8*. This pattern bears closely the characteristics of business/corporate banking; thus we can label *SG1* as *investment savings banks*. This characterization is reaffirmed when it is noted that the valuation of human capital, *R2*, is lower while the importance attached to physical capital, *R1*, is high.

SG2 can be labeled as *asset savings banks group*. Here we found firms that attach importance to commercial loans, *S1*. As far as the strategy concerning liabilities is concerned, the savings and deposit accounts, *S5*, and the inter-banking funds, *S6*, are similar to those of the rest of the sector.

The two biggest savings bank entities in Spain (La Caixa and Caja Madrid) belong to *SG3*. The emphasis in this group is on proximity to customers, *S8*, and savings and deposit accounts, *S5*. Firms in *SG3* have a very high proportion of earnings from financial services, *S4*, rather than from loans or corporate investments. Despite the size of some firms in this group, no special emphasis is put on physical assets, *R1* because *SG3* attaches importance to human capital, *R2*. Summing up, the strategy in *SG3* is focused on maximizing market quota, *S8*, principally by means of conservative formulas for capturing funds such as savings and deposit accounts, *S5*, and, then, by charging commission for supplying financial services, *S4*. Thus the role of employees, *R2*, becomes particularly relevant. We can refer to *SG3* as *passive/liability savings banks*.

When we analyze the performance implications of *SG* membership, we observe in Table IV that the selected performance indicators perfectly differentiate across groups.[3] More specifically, the *ANOVA* test shows that groups formed by clustering the stable long-run virtual weights exhibit significant differences for every indicator we use. Additionally, Table IV shows that members of *SG3* have the better results. This result could be interpreted as a change in the traditional business orientation of Spanish savings banks: originally, savings banks were orientated towards an active strategy of supplying commercial loans to a wide portfolio of customers. Now, the strategy has shifted to emphasize capturing an increasing number of clients and providing them with financial services. This pattern is very well represented by *SG3*.

INSERT TABLE IV ABOUT HERE

Performance Analysis

Strategic group theory suggests that, in addition to industry-source and firm specific-source, long-lasting firm profitability derives from the structure of the industry. In this structure, *SG* membership is the variable used to explain the persistent differences in the performance of the firms. Our goal here is to examine to what extent a statistical association between group membership and performance indicators can be found. Following Mehra (1996), a univariate *ANOVA* test is conducted to examine the association between the structure of the industry and the 1998-02 average performance of savings banks. To study the extent of the variability of the indicators that can be explained by *SG* membership, R^2 figures are computed for all performance indicators. Column 1 in Table V presents the results of our proposal, whereas the results of the traditional application of Cluster Analysis to the initial key decision variables are shown in columns 2 (for the 5 *SSTPs* specification) and 3 (for the 1 *SSTP* specification). As a resume, Table V illustrates the superiority of our proposal in explaining performance variability.

INSERT TABLE V ABOUT HERE

It is evident from the results that *SGs* based on virtual weights show significant differences across all performance indicators, although it is also true that the R^2 values are low for the traditional performance indicators (*ROA* and *ROE*). This situation can be explained, on the one hand, by the idiosyncratic not-for-profit status of Spanish savings banks. On the other hand, the competition from other banks, namely commercial banks, puts pressure on savings banks, forcing them to attain similar levels of efficiency to the competitors (Kumbhakar et al., 2001). This explains why savings banks exhibit high R^2 values for those indicators proposed by the Spanish Confederation of Savings Banks –prevalent when Spanish analysts and practitioners determine league tables– which are related to efficiency, such as the *Cost / Income* ratio or the so-called 'efficiency ratio', say *Ordinary Margin / Operative Costs*.

When we examine the average values of selected performance indicators, the stratification based on stable virtual weights exhibits a stronger fit: 8% of the *ROA* variance, almost 10% of the *ROE* variance, 7.5% of the *gross profit / ordinary margin* ratio variance, upwards of 24% of the *cost / income* ratio variance, almost 15% of the '*efficiency ratio*' variance, more than 13% of the *employee productivity* ratio, and 10% of the *profit to loans* ratio variance.

The capacity to explain the variability of the performance of *SGs* based on the stratification of the original strategic variables is considerably lower, particularly when *1-SSTP* is considered. Pairwise comparison (*1-SSTP* vs *5-SSTP*) shows a better fit for the *5-SSTPs*, a situation quite predictable because this is the solution identified as more desirable.

In summary, the general conclusion that can be drawn from our results is that the stratification of savings banks according the managers' perceptions exhibits a stronger fit. Indeed, the ability of *SGs* based on virtual weights to explain differences in performance is higher when long-term results (say, average performance indicators) are considered. These results reinforce the thesis of cognitive forces driving the process of *SG* formation, conferring more stability and explaining a higher percentage of intra-industry performance variance than the traditional way of clustering units on the original strategic variables.

CONCLUSIONS

The concept of strategic group has merited a great deal of attention within the strategic management and industrial organization literature (McGee and Thomas, 1986). But the debate in the literature about how strategic groups should be identified (Fiegenbaum and Thomas, 1990) goes on unabated. To address this limitation, this study has developed a framework for identifying *SGs*, and applied it to test whether the hypothesis of no differences in performance across groups and through the years can be supported. The paper has also proven empirically that this framework has a greater ability to explain intra-industry performance differences than the traditional analysis.

The basic proposition of this paper is that firms use given inputs in order to achieve certain results, and do so following different strategies. From this, it follows that firms in the same group convert inputs into outputs in the same way and, consequently, a *SG* can be defined as a set of firms that value inputs and outputs in the same way. From this valuation, we are able to approximate the cognitive models of managers through a simple criterion. In this context, *DEA* is an excellent tool for segmentation since the virtual weights provided are informative of the system of priorities of managers.

The very notion of *SGs* requires the existence of consistence and stability when analysed over a specified time period. The problem is that, irrespective of the time period considered, the existent *DEA* programs give a time-specific efficiency coefficient and time-specific weights what, in fact, supports the hypothesis of lack of *SGs*. From the theoretical point of view, this article presents and discusses the advantages of the definition of a stable *DEA* model focused on the long-run evaluation including the inputs and outputs corresponding to the global period under analysis.

From the applied section of the article, we have tested the proposed method through the study of the Spanish banking industry. The results indicate the potential contribution of our proposal towards a better understanding of the characteristics of *SGs*. To verify this, we have studied the ability of the identified strategic groups to maximize between-groups differences. Differences between *SGs* are observed for all the specified performance indicators. In order to increase the knowledge about the properties of our proposal, we compared the *SGs* composition we have obtained with the one obtained by traditionally running Cluster Analysis with the strategic variables. The results clearly state that segmentation on the basis of virtual weights exhibits a stronger fit and explains a more substantial percentage of intra-industry long-term performance variance.

Although the *SGs* determined via long-run efficiency evaluation explain a better proportion of the differences in profitability, an important part of the variability is yet to be explained. This result shows that, apart from the industry-effect and the *SG*-effect, there is clearly a firm specific effect that explains some of the differences in profitability. So, when trying to explain to what extent we can understand the variability of profitability among firms, the internal efficiency of firms continues to play a crucial role.

NOTES

[1] The procedure which we propose to test whether virtual weights are stable introduces a subtle difference with what Cool and Schendel (1987) proposed: we do not pool the data of *t* and *t+1* when no significant differences are found between these two years. The reason not to do this is simple: the frontier obtained from contemporaneous *DEA* evaluation is very different from that obtained from the intertemporal evaluation. Hence, we propose to test the null hypothesis of equality of the covariance matrix between each pair of periods.

[2] Full details of the results of cluster analysis of the original strategic variables may be obtained from the authors. To obtain the *SGs* when imposing the *1-SSTP* solution for the original strategic variables, we follow the proposal of Cool and Schendel (1987): the strategy variables are averaged over the 5 years for each sampled firm.

[3] The *ANOVA* analysis used to test the significance of the performance indicators among the *SGs* identified with the original variables shown that two indicators are not significant (*RNE* and *RNC*), and that only one indicator is significant at 10% (*ROA*). The remaining indicators are only significant at 5%

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Table I. SSTP determination: Virtual weights versus key decision variables

PANEL A. Differences on the contemporaneous virtual weights				
Null hypothesis	Bartlett's Test	Pillai's Trace	Wilks' Lambda	Hotelling-Lawley Trace
$\Sigma_{1998} = \Sigma_{1999}$	12.985 (1.233)	0.068 (1.518)	0.932 (1.518)	0.073 (1.518)
$\Sigma_{1999} = \Sigma_{2000}$	9.478 (0.900)	0.074 (1.651)	0.926 (1.651)	0.080 (1.651)
$\Sigma_{2000} = \Sigma_{2001}$	12.426 (1.180)	0.054 (1.180)	0.946 (1.180)	0.057 (1.180)
$\Sigma_{2001} = \Sigma_{2002}$	2.752 (0.261)	0.011 (0.223)	0.989 (0.223)	0.011 (0.223)

PANEL B. Differences on the original key decision variables				
Null hypothesis	Bartlett's Test	Pillai's Trace	Wilks' Lambda	Hotelling-Lawley Trace
$\Sigma_{1998} = \Sigma_{1999}$	42.263 (0.554)	0.470 (6.131)***	0.530 (6.131)***	0.887 (6.131)***
$\Sigma_{1999} = \Sigma_{2000}$	35.116 (0.460)	0.414 (4.886)***	0.586 4.886)***	0.707 (4.886)***
$\Sigma_{2000} = \Sigma_{2001}$	39.366 (0.516)	0.445 (5.541)***	0.555 (5.541)***	0.802 (5.541)***
$\Sigma_{2001} = \Sigma_{2002}$	33.415 (0.438)	0.238 (2.154)**	0.762 (2.154)**	0.312 (2.154)**

Notes: *F* values are seen in parentheses. In Bartlett's Test, Σ denotes the variance-covariance matrix. In the other tests, Σ denotes the vector of means.

***/**/* Significant differences at a 1% / 5% / 10% level.

Table II. **Statistical test of equal technologies between t and $t+1$**

Test of contemporaneous technologies	ANOVA *F* (Prob > *F*)	Kruskal-Wallis *x* (Prob > *x*)	Wilcoxon *Z* (Prob > *Z*)
Year 1998 – Year 1999	0.051 (0.821)	0.297 (0.586)	-0,282 (0,778)
Year 1999 – Year 2000	0.117 (0.733)	0.217 (0.641)	-0,501 (0,616)
Year 2000 – Year 2001	0.344 (0.559)	0.254 (0.614)	-0,724 (0,469)
Year 2001 – Year 2002	0.335 (0.564)	0.274 (0.601)	-0,698 (0,485)
Among all years	1,053 (0.381)	2.391 (0.664)	-

Table III. Characterization of strategic groups based on cluster virtual weights

***MANOVA*; *F* (Wilks) = 15.738 (*p* =0.000). Discriminant Analysis correctly classifies 100% of the sample Strategic groups**								
	Strategic Groups				**ANOVA**		**Kruskal-Wallis**	
	1	**2**	**3**	**Total**	**F test**	***p*-Value**	***Chi-sq.***	***p*-Value**
Output virtual weights:								
Commercial loans	0.0471	0.4968	0.0654	*0.2875*	71.8923	0.0000	31.8759	0.0000
	(0.0963)	(0.1289)	(0.1126)	*(0.2507)*				
Portfolio of securities	0.2299	0.0420	0.1266	*0.1044*	6.9692	0.0026	6.8970	0.0318
	(0.2271)	(0.0512)	(0.1355)	*(0.1468)*				
Treasury	0.1029	0.0386	0.0319	*0.0506*	5.1495	0.0104	3.0605	0.2165
	(0.1014)	(0.0374)	(0.0281)	*(0.0607)*				
Service commissions	0.2056	0.0808	0.2955	*0.1638*	9.7751	0.0004	12.0440	0.0024
	(0.1813)	(0.0877)	(0.1702)	*(0.1617)*				
Savings & Deposit accounts	0.0230	0.0366	0.0372	*0.0338*	0.1233	0.8844	0.8543	0.6524
	(0.0691)	(0.0737)	(0.0770)	*(0.0721)*				
Interbank position	0.0837	0.0855	0.0758	*0.0825*	0.0378	0.9629	0.2210	0.8954
	(0.0968)	(0.1077)	(0.0658)	*(0.0940)*				
Geographical reach	0.1317	0.0205	0.0401	*0.0495*	4.0368	0.0255	6.6787	0.0355
	(0.1492)	(0.0676)	(0.1066)	*(0.1068)*				
Proximity to customers	0.0378	0.0807	0.2400	*0.1132*	5.9933	0.0054	6.7458	0.0343
	(0.0730)	(0.1150)	(0.2230)	*(0.1615)*				
Input virtual weights:								
Physical capital	0.5727	0.1739	0.0485	*0.2265*	38.3875	0.0000	23.2493	0.0000
	(0.1626)	(0.1528)	(0.0735)	*(0.2339)*				
Human capital	0.3086	0.7721	0.8864	*0.7027*	37.2642	0.0000	21.7717	0.0000
	(0.1615)	(0.1808)	(0.0925)	*(0.2639)*				
Credit quality	0.1187	0.0540	0.0651	*0.0708*	3.2556	0.0493	3.3511	0.1872
	(0.0914)	(0.0539)	(0.0594)	*(0.0681)*				
Number of savings banks	*9*	*22*	*11*	*42*				

Note: Standard deviations are seen in parentheses

Table IV. Performance characterization of strategic groups based on cluster virtual weights

	Strategic groups				ANOVA		Kruskal-Wallis	
Indicators of performance:	**1**	**2**	**3**	***Total***	**F test**	***p*-Value**	***Chi-sq.***	***p*-Value**
ROA: Profit / total assets	0.0085	0.0086	0.0103	*0.0090*	6.2317	0.0024	6.3083	0.0427
	(0.0026)	(0.0031)	(0.0039)	*(0.0033)*				
ROE: Profit / equity	0.1343	0.1518	0.1578	*0.1496*	5.4303	0.0050	12.9255	0.0016
	(0.0354)	(0.0412)	(0.0283)	*(0.0378)*				
GP/OM: Profit / ordinary margin	0.3187	0.3123	0.3645	*0.3273*	5.5675	0.0044	9.1710	0.0102
	(0.1044)	(0.0824)	(0.1157)	*(0.0989)*				
CI: Cost / income	0.5932	0.5615	0.4945	*0.5507*	26.5845	0.0000	48.7314	0.0000
	(0.0966)	(0.0590)	(0.0684)	*(0.0792)*				
ER: Efficiency ratio	0.6443	0.6209	0.5654	*0.6114*	14.2267	0.0000	32.5141	0.0000
	(0.1009)	(0.0670)	(0.0790)	*(0.0832)*				
RNE: Profit / Number employees	30.6847	29.3377	43.3026	*33.2838*	9.6008	0.0001	12.1724	0.0023
	(15.4507)	(14.6977)	(23.9509)	*(18.6114)*				
RNC: Profit / loans	0.0145	0.0136	0.0178	*0.0149*	8.3928	0.0003	10.6054	0.0050
	(0.0058)	(0.0055)	(0.0081)	*(0.0065)*				
Number of savings banks	*9*	*22*	*11*	*42*				

Note: Standard deviations are seen in parentheses

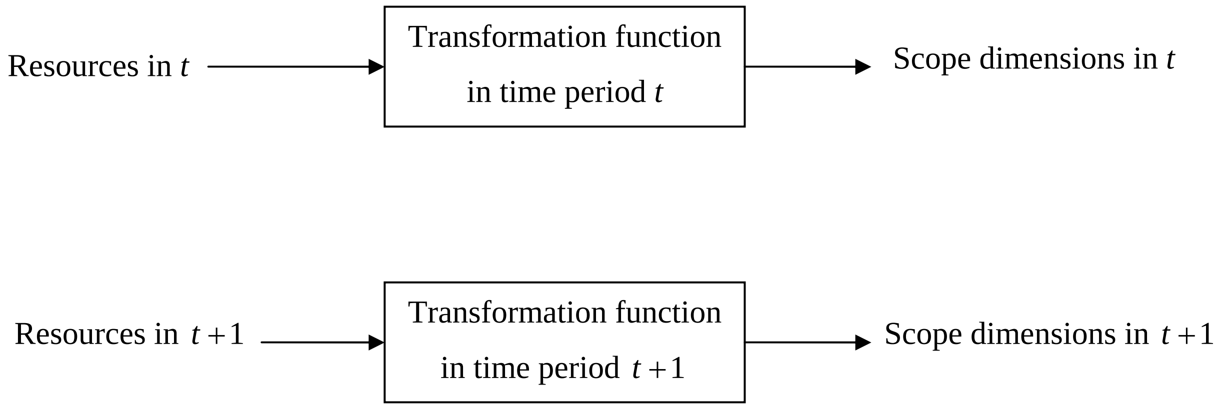
Table V. ANOVA R^2 fit for individual performance indicators

		Virtual weights (1 SSTP solution)	Key decision variables 5 *SSTPs solution*	1 SSTP solution
ROA	Profits / total assets	0.0802	0.0345	0.0362
		(0.0339)	(0.2252)	(0.2244)
ROE	Profits / equity	0.0960	0.0779	0.0674
		(0.0168)	(0.0319)	(0.0593)
GP_OM	Profits / ordinary margin	0.0753	0.0685	0.0317
		(0.0420)	(0.0489)	(0.2710)
CI	Cost / income	0.2436	0.0926	0.0334
		(0.0000)	(0.0161)	(0.2527)
ER	Efficiency ratio	0.1490	0.1149	0.0487
		(0.0015)	(0.0056)	(0.1326)
RNE	Profit / Number employees	0.1339	0.0393	0.0472
		(0.0606)	(0.4395)	(0.3895)
RNC	Profit / loans	0.1061	0.0156	0.0051
		(0.0106)	(0.5129)	(0.8132)

Notes: The significance level of the *F* values is shown in parentheses

Figure 1. Contemporaneous analysis and stable long-run analysis of firm's strategy

PANEL A. Contemporaneous analysis of firm's strategy



PANEL B. Stable long-run analysis of firm's strategy

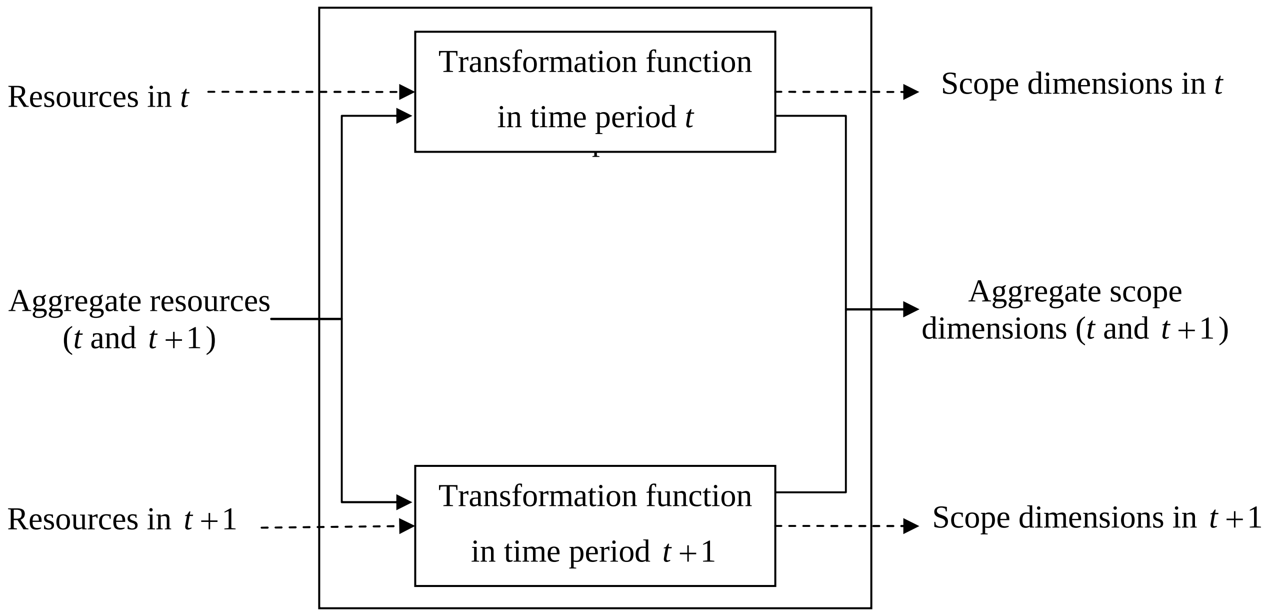
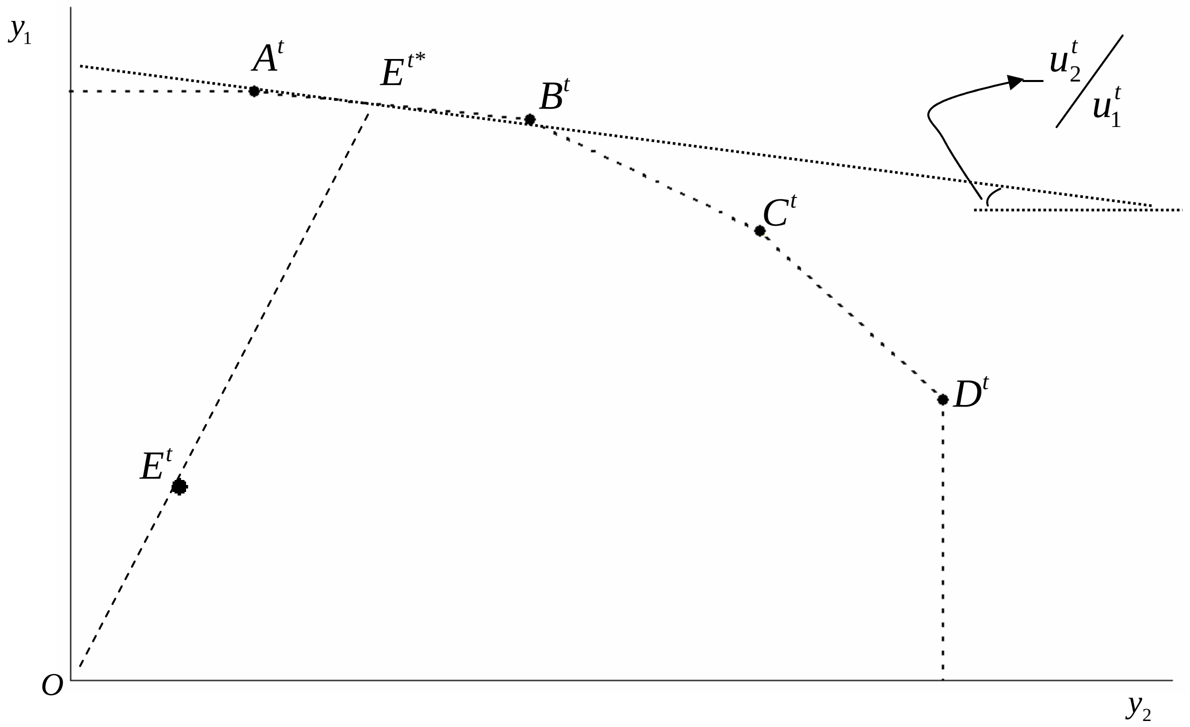


Figure 2. Contemporaneous *DEA* frontier

PANEL A. Frontier in (*t*)



PANEL B. Frontier in (*t + 1*)

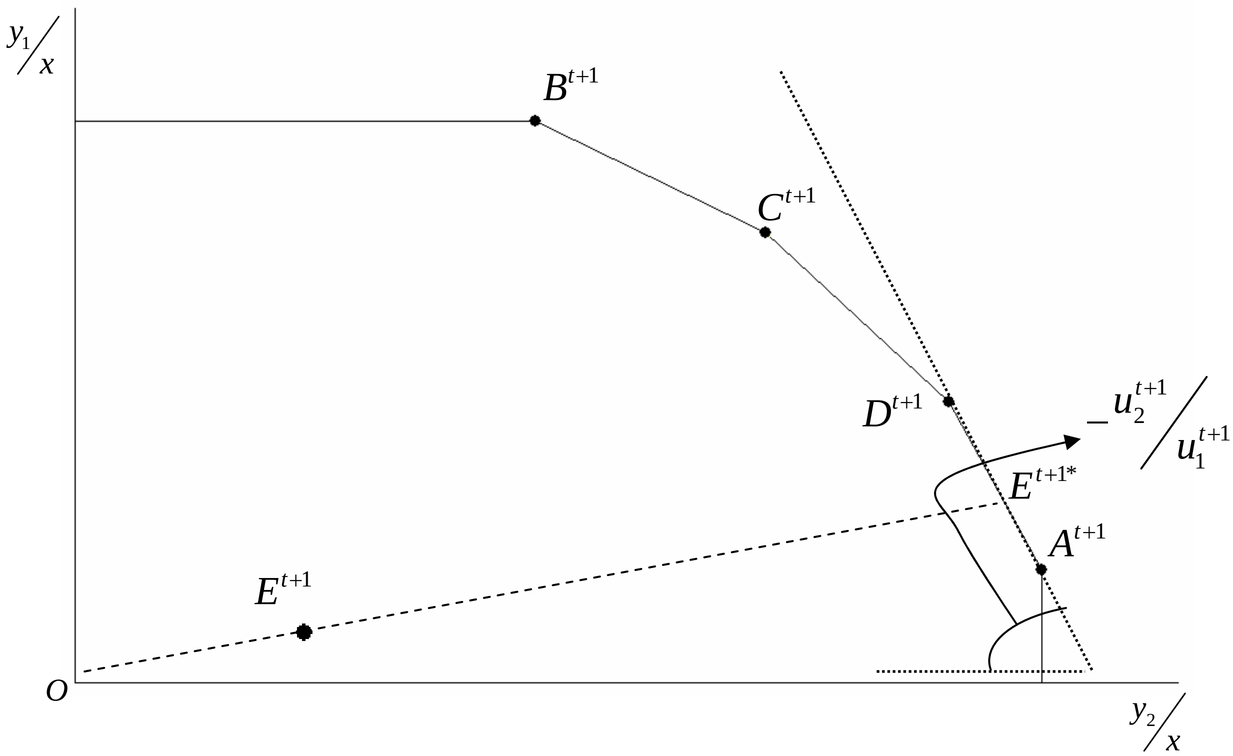


Figure 3. Intertemporal *DEA* frontier in t and t+1

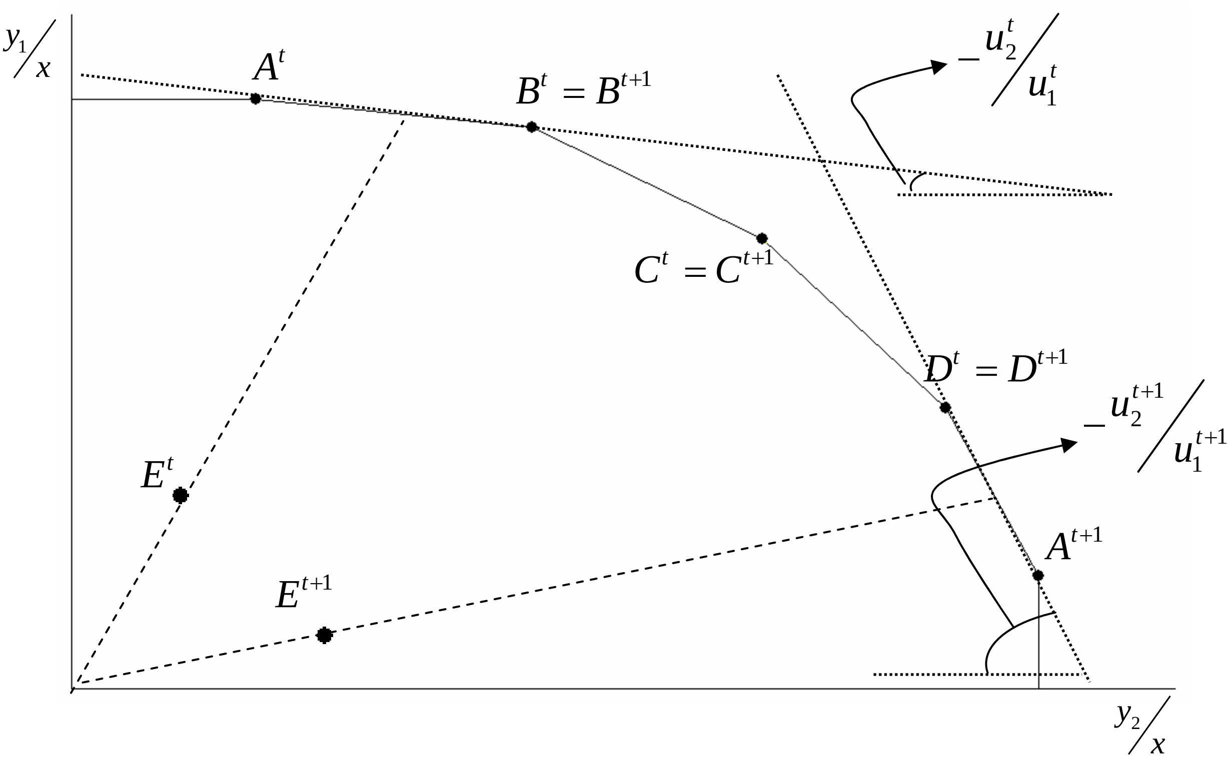
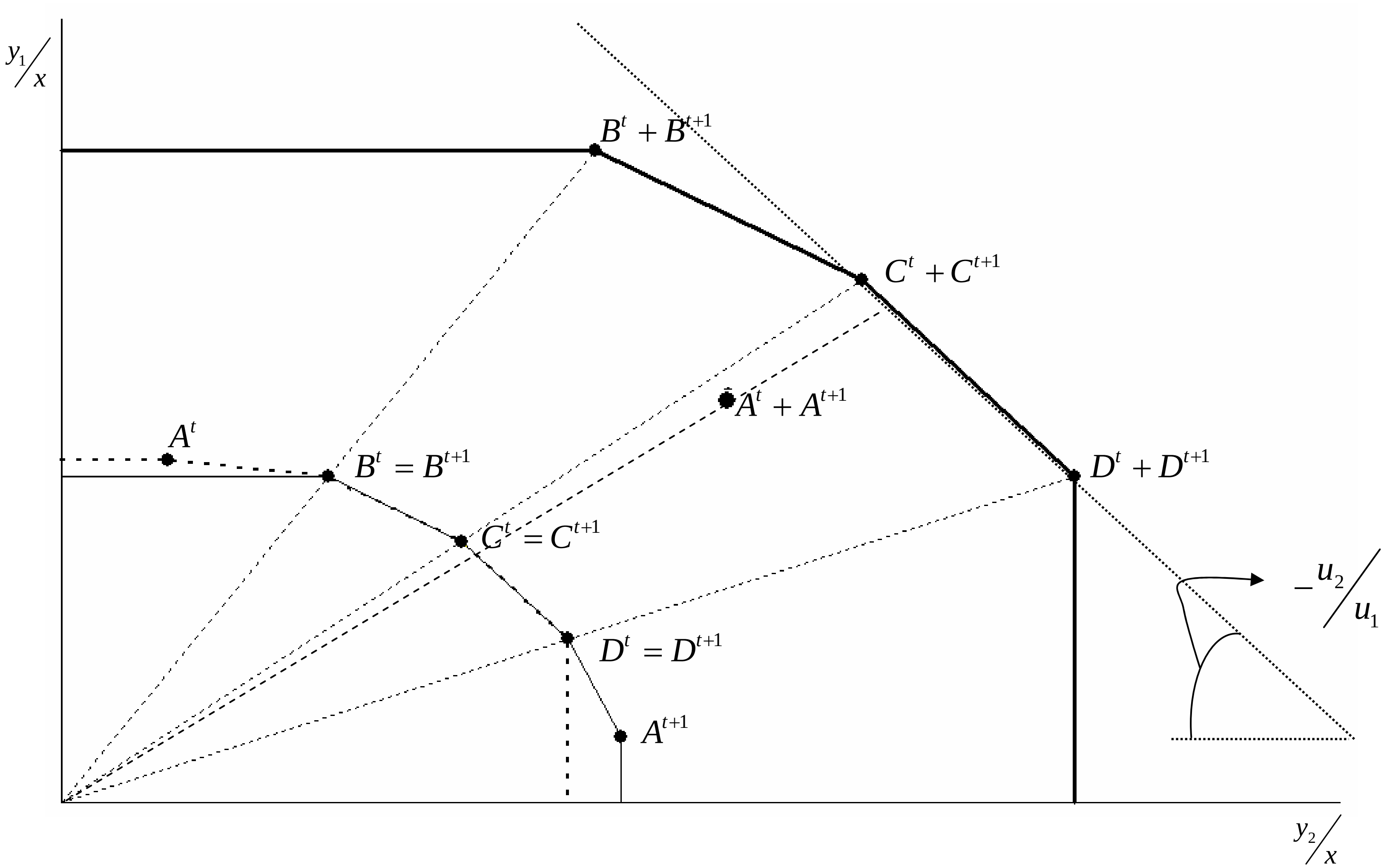


Figure 4. Intertemporal long-run *DEA* frontier with stable set of weights for *t* and *t+1*



APPENDIX 1. FORMULATING THE LONG-RUN *DEA* EFFICIENCY EVALUATION TO ASSIGN STABLE VIRTUAL WEIGHTS

Introducing some notation, assume that for S units $\left(s=1,...,S\right)$ there are N inputs $\left[x^{s}=\left(x_{1}^{s},...,x_{n}^{s},...,x_{N}^{s}\right)\in\Re_{+}^{N}\right]$ producing M outputs $\left[y^{s}=\left(y_{1}^{s},...,y_{m}^{s},...,y_{M}^{s}\right)\in\Re_{+}^{M}\right]$. Let $\left[x^{o}=\left(x_{1}^{o},...,x_{n}^{o},...,x_{N}^{o}\right)\in\Re_{+}^{N}\right]$ and $\left[y^{o}=\left(y_{1}^{o},...,y_{m}^{o},...,y_{M}^{o}\right)\in\Re_{+}^{M}\right]$ denote the variables corresponding to the *DMU* under analysis. With panel data, lets define a new variable t $\left(t=1,...,T\right)$ representing the time period when the inputs and outputs were measured: $\left[x^{s,t}=\left(x_{1}^{s,t},...,x_{n}^{s,t},...,x_{N}^{s,t}\right)\in\Re_{+}^{N}\right]$ and $\left[y^{s,t}=\left(y_{1}^{s,t},...,y_{m}^{s,t},...,y_{M}^{s,t}\right)\in\Re_{+}^{M}\right]$. Using the taxonomy introduced by Tulkens (1986), the following mathematical program gives the so-called *contemporaneous frontier efficiency coefficient* (evaluating each *DMU T* times):

$$
\begin{aligned}
\underset{u_m^{c,t},v_n^{c,t}}{Max}\quad & h^{c,t}=\sum_{m=1}^{M}u_m^{c,t}y_m^{o,t} \\
s.t.\quad & \sum_{n=1}^{N}v_n^{c,t}x_n^{o,t}=1; \\
& \sum_{m=1}^{M}u_m^{c,t}y_m^{s,t}-\sum_{n=1}^{N}v_n^{c,t}x_n^{s,t}\le 0;\quad s=1,...,S. \\
& u_m^{c,t},v_n^{c,t}\ge 0;\qquad m=1,...,M;\ n=1,...,N.
\end{aligned}
\qquad [1]
$$

Where $u_m^{c,t}$ and $v_n^{c,t}$ are the contemporaneous input and output weights corresponding, for period *t*, to the *DMU* under evaluation. The problem with the contemporaneous frontier is that we have a time-specific frontier and a time-specific efficiency coefficient. So, for *DMU* '*o*', we obtain *T* contemporaneous efficiency coefficients $\left(h^{c,1},...,h^{c,t},...,h^{c,T}\right)$, $T\times M$ output weights, $\left(u_1^{c,1},...,u_1^{c,T},...,u_M^{c,1},...,u_M^{c,T}\right)$, and $T\times N$ input weights, $\left(v_1^{c,1},...,v_1^{c,T},...,v_N^{c,1},...,v_N^{c,T}\right)$.

To connect the time periods, we can use what Tulkens refers as *intertemporal frontier*, defined in the following program:

$$
\begin{aligned}
\underset{u_m^{i',t},\,v_n^{i',t}}{Max} \quad & h^{i',t} = \sum_{m=1}^{M} u_m^{i',t} y_m^{o,t} \\
s.t. \quad & \sum_{n=1}^{N} v_n^{i',t} x_n^{o,t} = 1; \\
& \sum_{m=1}^{M} u_m^{i',t} y_m^{s,\tau} - \sum_{n=1}^{N} v_n^{i',t} x_n^{s,\tau} \le 0\,; \qquad s = 1,\dots,S;\ \tau = 1,\dots,T; \\
& u_m^{i',t}, v_n^{i',t} \ge 0; \qquad m = 1,\dots,M;\ n = 1,\dots,N.
\end{aligned} \qquad [2]
$$

In applying the intertemporal frontier, it is assumed the technology is invariant for all the time-periods. However, for each *DMU* we have *T* efficiency coefficients $\left(h^{i',1},\dots,h^{i',t},\dots,h^{i',T}\right)$, $T \times M$ output weights, $\left(u_1^{i',1},\dots,u_1^{i',T},\dots,u_M^{i',1},\dots,u_M^{i',T}\right)$, and $T \times N$ input weights, $\left(v_1^{i',1},\dots,v_1^{i',T},\dots,v_N^{i',1},\dots,v_N^{i',T}\right)$. Obviously, the consistency of the weights over different time-periods is not granted in advance.

To resolve the limitations pointed out, we propose a new stable long-run *DEA* evaluation. Among the desirable properties, our proposal offers a stable common set of weights for the complete time-period. The program that gives us the stable long-run *DEA* weights is:

$$
\begin{aligned}
\underset{u_m^{i''},\,v_n^{i''}}{Max} \quad & h^{i''} = \sum_{t=1}^{T} \sum_{m=1}^{M} u_m^{i''} y_m^{o,t} \\
s.t. \quad & \sum_{t=1}^{T} \sum_{n=1}^{N} v_n^{i''} x_n^{o,t} = 1; \\
& \sum_{m=1}^{M} u_m^{i''} y_m^{s,\tau} - \sum_{n=1}^{N} v_n^{i''} x_n^{s,\tau} \le 0\,; \qquad s = 1,\dots,S; \quad \tau = 1,\dots,T; \\
& u_m^{i''}, v_n^{i''} \ge 0; \qquad m = 1,\dots,M;\ n = 1,\dots,N.
\end{aligned} \qquad [3]
$$

Applying program *[3]*, we now have one long-run efficiency coefficient $\left(h^{i''}\right)$, *M* output weights, $\left(u_1^{i''},\dots,u_M^{i''}\right)$, and *N* input weights, $\left(v_1^{i''},\dots,v_N^{i''}\right)$ for each *DMU*. Besides the determination of the stable common set of weights, program *[3]* also has three additional properties: a) It is less dependent on the specific values of the variables in one particular year; b) It ensures that no changes in the valuation system takes place across time periods; and c) the aggregation does not implies any lost in information because the restrictions defining the technology of programs *[2]* and *[3]* are exactly the same.

APPENDIX 2. STRATEGIC GROUP MEMBERSHIP OVER THE PERIOD 1998-02: *SGs* DEFINED WITH THE INTERTEMPORAL VIRTUAL WEIGHTS VERSUS *SGs* DEFINED WITH THE KEY DECISION VARIABLES

Saving bank	Virtual weights 98-02	Key decision variables 98	99	00	01	02	98-02
M.P. y C. General de A. de BADAJOZ	1	1	1	1	3	3	3
C.A. Municipal de BURGOS	1	3	3	3	3	3	3
C.A. Provincial de GUADALAJARA	1	3	3	3	3	3	3
C.A. de NAVARRA	1	3	3	1	3	3	3
C.A. de SANTANDER Y CANTABRIA	1	3	3	3	3	3	3
CAJA SAN FERNANDO de SEVILLA y JEREZ	1	1	1	1	1	1	1
C.A. Municipal de VIGO	1	1	1	1	1	1	1
C.A. y M.P. de EXTREMADURA	1	1	1	1	1	3	1
C.A. de CASTILLA LA MANCHA	1	2	2	2	2	2	2
C.A. de CATALUNYA	2	1	1	3	1	3	1
C.A. y M.P. de CÓRDOBA. CajaSur	2	1	1	1	1	1	1
C.E. de GIRONA	2	3	3	3	3	3	3
C. General de A. GRANADA	2	1	1	1	1	1	1
C.A. de LA RIOJA	2	3	3	3	3	3	3
C.E. Comarcal de MANLLEU	2	3	3	3	3	3	3
C.A. y M.P. de las BALEARES	2	3	3	3	3	3	3
C. Insular de A. de CANARIAS	2	3	3	3	3	3	3
C.E. de SABADELL	2	3	3	3	3	3	3
C. General de A. de CANARIAS	2	3	3	1	3	3	3
C.A. y M.P. de SEGOVIA	2	1	1	1	1	1	1
C.E. de TERRASSA	2	3	3	3	3	3	3
C.A. de Valencia, Castellón y Alicante. BANCAJA	2	1	1	1	1	1	1
C.A. y M.P. de ZARAGOZA ARAGÓN Y RIOJA	2	2	2	2	2	2	2
C.A. de la INMACULADA DE ARAGÓN	2	3	3	3	3	3	3
C.A. del MEDITERRÁNEO	2	1	1	1	1	1	1
C.A. de GALICIA	2	1	1	2	2	2	2
C. Provincial de A. de JAÉN	2	3	3	3	3	3	3
C.A. y M.P. de ÁVILA	2	1	1	1	1	3	3
CAJA ESPAÑA de Inversiones	2	2	2	2	2	2	2
M.P. y C.A. de HUELVA y SEVILLA	2	1	1	1	1	1	1
C.A. de SALAMANCA y SORIA - Caja Duero	2	2	2	2	2	2	2
C.A. y M.P. de MADRID	3	1	1	1	1	1	1
C.E. de MANRESA	3	3	3	3	3	3	3
C.E. LAIETANA	3	3	3	3	3	3	3
C.A. de MURCIA	3	1	1	1	1	3	1
C.A. de ASTURIAS	3	1	1	1	3	3	3
C.E. del PENEDÉS	3	3	3	3	3	3	3
BILBAO BIZKAIA KUTXA	3	1	1	1	1	3	1
C.A. y M.P. de VITORIA y ALAVA. Caja Vital	3	1	3	1	3	3	3
C.A. y Pensiones de BARCELONA - La Caixa	3	2	2	2	2	2	2
C.A. y M.P. de GIPUZKOA y SAN SEBASTIÁN	3	3	1	1	1	1	1
UNICAJA	3	2	1	2	1	1	2